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ABSTRACT

The Standards of Learning Program for Virginia Public Schools is designed to identify what students are expected to accomplish, to provide a method for determining what has been learned, and to encourage teachers to give additional instruction when needed. This document provides a broad framework for science programs and specifically identifies learner outcomes at each grade level for K-12 grades. Program goals, program objectives, and curriculum guidelines are described in detail. Curriculum guidelines are given for each program objective and serve as suggestions for translating program objectives into learner outcomes and in developing instructional techniques for the outcomes. Broad attitudinal, behavioral, and conceptual themes are used to articulate the K-12 science program and are graphically illustrated in the appendix. A listing of contributors to this program is also included. (ML)

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PROGRAM GOALS, PROGRAM OBJECTIVES, AND LEARNER OUTCOMES FOR K-12 SCIENCE

Science Education Service
Virginia Department of Education
Richmond, Virginia
October, 1982

MESSAGE FROM THE SUPERINTENDENT OF PUBLIC INSTRUCTION

I would like to introduce you to the Standards of Learning Program. The program establishes a framework for instruction in the public schools. It includes objectives which will help students acquire the knowledge, skills, and attitudes believed necessary for further education and employment.

The basis for the Standards of Learning Program is an objective adopted by the Board of Education in June 1981. The objective reads as follows:

> Basic skills and knowledge to be expected of students at each developmental level will be identified and published for kindergarten through grade 12. Objectives for language arts and mathematics will be completed by September 1982 and objectives for other subject areas and vocational education will be completed by September 1984 for grades K-12. Assessment instruments for use in teaching and remediation will be made available to those school divisions which do not have such instruments of their own.

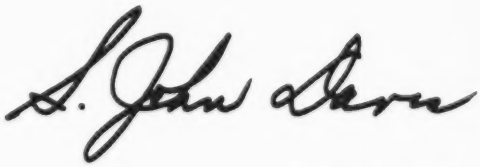
In addition to the benefits for students and teachers, the program will provide parents and other citizens with a better understanding of what students are expected to learn. With this understanding, all of us will be able to work together to help students achieve the objectives.

Standards of Learning Objectives in Language Arts, Mathematics, Social Studies, Science and Health have been developed over a three-year period with the aid of thousands of teachers, supervisors, administrators, teacher educators, and representatives of professional organizations and lay groups. I express sincere appreciation to the many individuals throughout the state who assisted in writing, reviewing and refining the objectives.

The Standards of Learning Program is designed to identify what students are expected to accomplish, to provide a method for determining what has been learned, and encourage teachers to give additional instruction when needed. It is not intended to reduce the total school program to a single list of objectives or to replace the curriculum that a school division already may have developed for its students. The staff in school divisions which already have such programs will need to examine them to ensure that the Standards of Learning Objectives are included.

During the 1982-83 school year, department personnel will work with you to help you become familiar with the objectives and how they may be used for planning instruction. It is anticipated that the Social Studies, Science and Health objectives will be used beginning in the fall of 1983.

I am excited about the program and am confident that it will be a success if we continue to work together.



S. John Davis

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1981, 1982

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INTRODUCTION

The Virginia Department of Education is establishing standards for K-12 science programs. A committee of science educators, with statewide representation, produced this document. The process of developing the document was begun in 1978. Various revisions have led to the present document. Revisions were made based upon suggestions received from classroom teachers, college science teachers, local school administrators, and others.

The introduction begins by outlining a broad framework for science and then becomes more specific for grade levels and subjects. The organizational scheme proceeds as follows:

I. Program Goals
   A. Program Objectives
      1. Guidelines
         a. Learner Outcomes

Program goals, program objectives, and curriculum guidelines are described in detail on pages 2 to 7. Program goals and program objectives have their foundation in the Standards of Quality for Virginia Schools and the National Science Teachers Association "Position Statement for School Science". While the program goals and objectives form the science framework, they have important application for the other curriculum areas. Curriculum guidelines are statements found under each program objective. The guidelines are suggestions for translating program objectives into learner outcomes and can be useful in developing instructional techniques for the learner outcomes. Curriculum guidelines are suggestions and are not intended to be all inclusive.

Broad attitudinal, behavioral and conceptual themes are used to articulate the K-12 science program. The nature of this K-12 articulation is graphically illustrated in the Appendix on page 49 and the themes are described in detail in specific curriculum guidelines. The themes are developed continuously through all grade levels as illustrated in the Appendix.

PROGRAM GOALS AND OBJECTIVES
WITH SUGGESTED CURRICULUM GUIDELINES

Program Goal I — **The science program should be consistent with the intellectual, social, emotional, and physical development of the student.**

Program Objective A: The science program should encouarge students to become self-directed learners.

Guidelines:

1. Provide opportunities to work independently and as a member of both small and large groups in order to encourage sharing, accepting responsibility, and decision-making.

SELF DIRECTION

2. Provide an opportunity for the student to select, plan, prepare for, implement, and evaluate a science experience.
3. Provide guidance for students concerning the safe and proper use of science materials.

Program Objective B: The science program should include experiences which foster group interactions.

Guidelines:

1. Provide opportunities to interact with people of various ages and from a wide range of backgrounds.

GROUP INTERACTION

2. Provide experiences in science which promote both responsibility and contribution to the group.

Program Objective C: The science program should contribute to the development of a positive and realistic self-concept in students.

Guidelines:

1. Provide multi-level experiences through which each student can meet success, and individual differences can be accepted.

SELF CONCEPT

2. Provide opportunities to establish appropriate goals which will be evaluated by both the student and teachers.

Program Objective D: The science program should recognize the growth characteristics of students.

Guidelines:

GROWTH CHARACTERISTICS

1. Provide active laboratory and field experiences.
2. Provide activities at different levels of concrete and formal operations which consider the nature of the learner.

PROGRAM GOAL II: **The science program should be consistent with the nature of science which includes its philosophy, methods of investigation and verification, conceptual organization, and accumulated knowledge.**

Program Objective A: The science program should emphasize process skills beginning with basic processes at the elementary level and continuing with the integrated skills at higher grade levels.

Guidelines:

PROCESS SKILLS

1. Provide activities which will help students develop the skill of **observation** using all of the senses.
2. Provide activities which help students develop the skill of **classifying** objects or events according to a method or system.
3. Provide opportunities for students to **communicate** data obtained from observations using graphs, charts, pictures, or other types of media.
4. Provide opportunities for students to describe or compare objectives and events using quantitative **measures.**
5. Provide opportunities for students to make **inferences** (suggest explanations, reasons, or causes for events which have occurred), test them with additional observations or data, and establish the reliability of the inferences.
6. Provide opportunities for students to make **predictions** based on prior observations, inferences, or experiments.
7. Provide opportunities for students to identify problems or questions and state **hypotheses** which can be tested.

8. Provide opportunities for students to perform **experiments** to test hypotheses under controlled conditions in which variables are limited.
9. Provide opportunities for students to **construct and interpret models** (mental, physical, or verbal representations or ideas, objects, or events).
10. Provide opportunities for students to **interpret data**, a skill which involves observing, classifying, predicting, inferring, and communicating information which is meaningful, useful, and appropriate to the question under study.

Program Objective B: The science program should develop the overall conceptual themes of science.

Guidelines:

CONCEPTUAL THEMES

1. Provide opportunities for students to become aware of the processes of change: such as is recorded in the earth's history, the development of weather systems, life cycles, evolution, chemical and physical changes, and the transformation of energy. **(Change)**
2. Provide opportunities for students to become aware of the processes of equilibrium: such as in weather systems, physical cycles, ecosystems, homeostasis, chemical equilibria, and rates of reaction, and the laws of motion. **(Equilibrium)**
3. Provide experiences in which students investigate the interrelationships which exist among living and non-living things and their environment. **(Interrelationships)**
4. Provide experiences for students to explore the organization of the physical and biological environment and the systems designed by man to describe it. **(Organization)**
5. Provide situations in which students will explore the effects of time and space upon the biological and physical aspects of the earth's environment. **(Time/Space)**
6. Provide opportunities to become aware of the diversity and variation among living things (i.e., speciation and habitats); and within the physical universe (i.e., elements and compounds; forms of energy); and of the variety of interactions that occur. **(Variation)**
7. Provide experiences which demonstrate that matter and energy are continually being redistributed in the physical and biological spheres of the earth. **(Energy/Matter)**

Program Objective C:

The scope and sequence of the program should involve integration of physical and biological science with special emphasis upon the environment.

Guidelines:

SCOPE & SEQUENCE

1. In the primary grades (K-1) explore the characteristics of material objects and living things found in the immediate environment.
2. In the intermediate grades (2-3) explore the interactions between material objects and living things within the community.
3. In the upper elementary grades (4-5) examine the effects of manipulated variables in the extended environment.
4. In grade 6 examine the basic components of the physical and biological environment.
5. At the 7th grade level explore the biological sciences as they apply to the environment.
6. At the 8th grade level study the physical sciences as they apply to the environment.
7. In the four years of secondary school students should be introduced to several science disciplines rather than a sequence of courses in one discipline.
8. Advanced placement courses in science may be offered for a fifth unit of credit for those students who have the requisite abilities and motivation.
9. Science courses should encompass the broad scope of the discipline.
10. In all grades, provide a program with strong emphasis on laboratory experiences.
11. In all grades, provide field experiences as an integral part of the science program.

Program Objective D:

The science program should emphasize the development of scientific values.

Guidelines:

Provide activities which will instill in students:

SCIENTIFIC VALUES

1. longing to know and understand
2. questioning of all things
3. search for data and their meaning
4. demand for verification
5. respect for logic
6. consideration of premises
7. consideration of consequences
8. respect for historical contributions

PROGRAM GOAL III: **The science program should reflect an involvement with both immediate and future life needs in terms of solving personal and social problems.**

Program Objective A: The science program should emphasize the utilization of scientific values as guides for the examination of problems and experiences in a rapidly changing scientific and technological society.

Guidelines:

UTILIZATION OF SCIENTIFIC VALUES

1. Provide opportunities for students to use systematic approaches to investigate real problems in the community.
2. Provide opportunities for students to use systematic approaches to make personal decisions.

Program Objective B: The science program should emphasize the role of man and science in the natural world.

Guidelines

ROLE OF MAN & SCIENCE

1. Provide opportunities for students to become aware of the role science plays in their daily lives.
2. Provide opportunities for students to observe and analyze man's role within the natural environment.
3. Provide opportunities for students to develop an understanding of how man can use science to help him live in harmony with the natural world.
4. Provide opportunities for students to be aware of both the power and the limitations of science.

Program Objective C: The science program should provide information about careers and avocations in various areas of science.

Guidelines:

CAREER GOALS

1. Provide opportunities for students to observe and study science and technology.
2. Provide appropriate background for the pursuit of careers in science and technology.
3. Provide opportunities which allow students to pursue scientific and technical interests.

PROGRAM GOAL IV: **The science program should relate to other curricula areas.**

Program Objective A: Appropriate concepts, processes, values, and skills of other disciplines should be integrated into science.

Guidelines:

1. Apply computational and measurement skills and concepts in solving problems.
2. Use the process skills in investigating environmental problems.
3. Use communication skills as a part of science.
4. Provide field and classroom experiences which incorporate skills and concepts from other disciplines.
5. Relate science to other disciplines.

RELATIONSHIP WITH OTHER DISCIPLINES

Program Objective B: The science program should integrate concepts, processes, values, and skills among the various areas of science.

Guidelines:

1. Provide opportunities for the positive reinforcement of concepts, processes, values, and skills which are common to all sciences.
2. Provide opportunities to stress themes common to all sciences.

INTEGRATE ALL SCIENCES

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
KINDERGARTEN

K.1 **The student will share responsibilities and tasks, and use materials in a safe manner.**

K.2 **The student will identify the body organ associated with each of the five senses, and use the senses to observe and describe common objects.**

K.3 **The student will describe an object on the basis of color, shape, texture, size, and position.**
Descriptive Statement: These descriptions should include the eight basic colors; the four basic shapes; textures such as rough-smooth, hard-soft; size in terms of large-small, big-little; positions such as in-out, over-under. This is not intended to include left-right as position.

K.4 **The student will sort and classify objects using one variable.**
Descriptive Statement: Objects with similar characteristics should be physically grouped by the child.

K.5 **The student will compare two concrete objects by using terms which refer to length, width, size, or weight.**
Descriptive Statement: Terms as longer-shorter, heavier-lighter, fatter-thinner, bigger-smaller should be used. The objects should be compared using only one variable at a time.

K.6 **The student will demonstrate increasing curiosity about the world around him.**
Descriptive Statement: Examples of curiosity include watching and wondering, telling experiences, and asking questions.

K.7 **The student will classify objects as floating and sinking while participating in water play activities.**
Descriptive Statement: The student should guess which of a given set of objects will float and which will sink before actually testing the objects in a container of water.

K.8 **The student will classify objects as attracted or not attracted by a magnet while working with a magnet.**
Descriptive Statement: The student should guess which of a given set of objects will be attracted by a magnet before actually testing the objects with a magnet.

K.9 **The student will observe that the form of objects can be changed.**
Descriptive Statement: Examples of common changes in form are water to ice, batter to cake, clay ball to clay rope, sugar to sugar water.

K.10 **The student will observe and describe daily weather conditions.**
Descriptive Statement: Terms such as hot, cold, rainy, sunny, cloudy, foggy, snowy, clear, warm, cool should be used.

K.11 **The student will describe the characteristics of living things and identify familiar objects as living or non-living.**
Descriptive Statement: Awareness that living things grow and need food, water, and air to survive is required.

K.12 **The student will describe some ways in which living things change as they grow and develop.**
Descriptive Statement: Changes may include size, color, shape, form or activities.

K.13 **The student will match parents and their offspring.**
Descriptive Statement: Common animals with which the child is familiar should be used.

K.14 **The student will observe and describe similarities and differences between various environments.**
Descriptive Statement: Environments such as home-school; country-city; and zoo-jungle, should be used for comparisons.

K.15 **The student will demonstrate ways to conserve energy and natural resources which are commonly used.**
Descriptive Statement: This includes turning off water after use, turning off lights either in school or at home, closing doors, and not wasting paper.

K.16 **The student will demonstrate a responsible attitude toward the home and school environment by participating in a waste management program.**
Descriptive Statement: Examples include making fire starters from scrap paper, recycling aluminum cans or returnable bottles, picking up litter, and keeping a compost pile.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
FIRST GRADE

1.1 **The student will share responsibilities and tasks, and use materials in a safe manner.**
Descriptive Statement: Cooperative participation in each stage of an activity is expected.

1.2 **The student will classify objects according to opposite properties.**
Descriptive Statement: Properties such as float-sink; living-nonliving; and heavy-light should be used.

1.3 **The student will put in order a collection of at least three like objects according to size or weight and describe them.**
Descriptive Statement: This includes smallest to largest, lightest to heaviest, and shortest to tallest.

1.4 **The student will measure concrete objects using non-standard units.**
Descriptive Statement: Some non-standard units are paper clips, pencils, hands, and feet.

1.5 **The student will classify events in which he participates according to time categories such as morning, noon, or night, day of the week, or season of the year.**

1.6 **The student will place objects in front of a light source and describe them according to the type of shadow they cast from various angles.**
Descriptive Statement: Two and three dimensional objects, and objects which are transparent, translucent, and opaque should be used.

1.7 **The student will demonstrate that the wheel and the inclined plane are used to make work easier and identify their uses in common objects.**
Descriptive Statement: Examples are bicycles, wheeled toys, ramps for the handicapped, and sliding boards.

1.8 **The student will demonstrate that some common materials dissolve in water and some do not.**
Descriptive Statement: Common materials such as salt, sugar, dirt, sand, rocks, and oil should be used.

1.9 **The student will identify sounds as loud or soft, and high or low.**

1.10 **The student will identify the four seasons and observable seasonal changes.**
Descriptive Statement: It terms of seasonal changes, use events such as leaves falling, budding of trees, animal hibernation, different types of precipitation, and changes in animals' actions (hibernation, migration) and appearance.

1.11 **The student will describe the basic needs and parts of green plants.**
Descriptive Statement: Experience in observing plants under different conditions is essential. Plants need nutrients (food), water, air, sunlight, and a place to live. Many plants have roots, stems, leaves, and seeds.

1.12 **The student will tell the basic needs of animals and describe some animal characteristics.**
Descriptive Statement: Animals need food, water, air and a place to live. They have different kinds of body structures and body coverings. Comparisons with human needs and characteristics should be included.

1.13 **The student will tell ways in which various living things are affected by their environment.**
Descriptive Statement: Living things would include plants, people and other animals. Some environmental factors to be considered are weather and climate, pollution, urbanization, and availability of resources such as water and fuel.

1.14 **The student will identify some commonly used natural resources, describe ways they are used, and tell what he can do to conserve them.**
Descriptive Statement: Examples of common natural resources include oil, water, trees and land.

1.15 **The student will identify some major sources of air, land, and water pollution.**
Descriptive Statement: Examples include automobile exhaust, smoke, litter, and waste in water.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
SECOND GRADE

2.1 **The student will share responsibilities and tasks, and use materials in a safe manner.**

2.2 **The student will observe and describe changes that take place over time in both living and non-living things.**
Descriptive Statement: Examples of changes are plant and animal growth, seasonal changes, metal rusting, erosion or deposition of soil after a rain, and decaying food.

2.3 **The student will select the appropriate instruments used to make measurements of length, weight, volume, temperature.**
Descriptive Statement: Instruments to be identified are a meter stick, balance scale, liter container, and thermometer.

2.4 **The student will record and describe information gathered from observations or measurements.**
Descriptive Statement: A graph, a chart, or other appropriate means may be used to record observations. The emphasis should be on accurate recording, and interpretation of data. Examples of situations to observe and record are weather changes, growth or changes in living things, and changes in the state of matter (solid, liquid, gas).

2.5 **The student will make inferences after observations of an object or event.**
Descriptive Statement: Inferences can be drawn by asking questions such as "What is this?" or "What happened here?" Examples of situations which might be used to elicit inferences are paths across the schoolyard, holes in a leaf, and a familiar object in an unfamiliar place.

2.6 **The student will observe physical events and predict their outcomes.**
Descriptive Statement: Predictions should be based on past experiences with similar situations. Examples include predicting what happens when a force is applied to a stationary object (e.g. a bat striking a ball), or the result of heat being applied to a liquid (e.g. boiling water).

2.7 **The student will classify substances as solids, liquids, or gases.**

2.8 **The student will observe and describe simple changes in matter from one state to another.**
Descriptive Statement: The change from ice to water to water vapor (evaporation) should be used as an example.

2.9 **The student will describe the effect of seasonal changes on himself and his environment.**
Descriptive Statement: Examples include telling how changes in season effect common plants and animals and the dress, diet and recreation of people.

2.10 **The student will know the basic life stages of living things.**
Descriptive Statement: The student should have personal experiences with several plants or animals which demonstrate that life goes through a series of orderly changes. Examples include watching and describing the transition of the egg to tadpole to frog and observing the progression from flower to formation of fruit.

2.11 **The student will demonstrate proper care and handling of living organisms and show respect for life.**

2.12 **The student will know that green plants produce and store food.**
Descriptive Statement: Examples of this process are fruits, seeds, sap, nuts, and berries.

2.13 **The student will know that there are different kinds of pollutants in the environment and will suggest possible methods for reducing them in his community.**
Descriptive Statement: This refers to general categories of pollutants such as noise, small (and sometimes invisible) things in the air and water, and litter. Students might participate in a litter clean-up, encourage others to reduce inappropriate noise in the cafeteria or auditorium, and walk to school rather than ride.

2.14 **The student will conduct activities involving separation of combined materials (mixtures).**
Descriptive Statement: Examples include separating salt and water by evaporation, sand and iron with a magnet, wood shavings and gravel by adding water, and dirt from water by filtering.

2.15 **The student will describe and demonstrate some general characteristics of static electricity.**
Descriptive Statement: Through having the opportunity to charge objects such as balloons and combs, the student will describe how the objects interact. Explanations are to be in the general terms of attraction and repulsion and should not include charges.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
THIRD GRADE

3.1 **The student will share tasks and resposibilities, and use materials in a safe manner.**

3.2 **The student will observe and classify objects into the sets and subsets of similar characteristics.**
Descriptive Statement: The intent of this objective is to develop two stage classification skills. An example would be to first sort a group of buttons by size and then by color.

3.3 **The student will use basic metric units of measurements in classroom and real world situations.**
Descriptive Statement: The units should be: length to the nearest cm, weight to the nearest gm, volume to the nearest liter, and temperature to the nearest degree centigrade.

3.4 **The student will record and describe information gathered from first-hand experiences.**
Descriptive Statement: An example is to record the growth of a plant on a graph or chart and describe to someone what took place using the recorded information.

3.5 **The student will infer the possible cause and effect of an event.**
Descriptive Statement: Students are expected to suggest plausible causes for situations or events. An example would be to ask "Why doesn't grass grow on all parts of the schoolyard?"

3.6 **The student will describe a given object's position and motion in relation to self.**
Descriptive Statement: Positions such as left-right, higher-lower, near-far, north-south-east-west should be used. Motion refers to such terms as faster-slower, and toward-away.

3.7 **The student will place natural events in order and use the sequence to tell what comes next.**
Descriptive Statement: Animal growth, plant growth, and geological changes, may be used to identify sequence.

3.8 **The student will describe some forms of energy and tell some ways energy is produced.**
Descriptive Statement: Some forms of energy to be studied are light, electricity, heat, and motion. Some sources of energy are: wind, sunlight, nuclear power, water, fossil fuels (coal, oil, natural gas), and wood.

3.9 **The student will identify the types of simple machines and demonstrate the use of each.**
Descriptive Statement: Lever, screw, pulley, wheel and axle, inclined plane, wedge are the six simple machines.

3.10 **The student will understand that white light is a combination of many colors.**
Descriptive Statement: The student should have the opportunity to use a prism to split white light into the spectrum of colors.

3.11 **The student will describe the sun and demonstrate that it provides heat and light which are necessary for life on earth.**
Descriptive Statement: The description of the sun should simply state that it is a ball of gas which produces intense heat and light. Demonstration of the sun's ability to produce heat should compare similar objects placed in sun and shade. Our need for light can be illustrated by placing a plant in darkness.

3.12 **The student will identify the major components of soil and describe the importance of soil to life on earth.**
Descriptive Statement: The major components can be described as pieces of rocks, and formerly living matter. All animals are directly or indirectly dependent upon plants for food and soil provides the base and minerals for plant growth.

3.13 **The student will draw or label the basic stages of the water cycle.**

3.14 **The student will observe and describe how animals behave in different ways to meet their life needs.**
Descriptive Statement: Students should compare several species of animals to see how their methods of gathering food, finding shelter, raising young, and defending themselves are different.

3.15 **The student will identify some characteristics of major groups of plants and animals.**
Descriptive Statement: For these purposes, the general groups are animals with backbones (e.g. mammals, birds, fish), and animals without backbones, (e.g. insects, worms, shellfish). The general plant groups are: those with stems (e.g. trees, flowers) and plants without stems (e.g. algae, moss, fungi).

3.16 **The student will describe the relationship between the organisms in a simple food chain in both aquatic and terrestrial environments.**
Descriptive Statement: The terms "producer" and "consumer" can be introduced.

3.17 **The student will know that species of plants and animals may become endangered or extinct.**
Descriptive Statement: Study of this topic should include possible reasons for extinction and examples of what is being done to protect endangered species today.

3.18 **The student will know that different populations of plants and animals are found in different environments.**

Descriptive Statement: This should include plants and animals found in several of the following environments: pond, grassland, stream, forest, desert, soil, and marsh environments.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
FOURTH GRADE

4.1 **The student will identify and select tasks and responsibilities, and use materials in a safe manner.**
Descriptive Statement: The intent is to help students learn to work cooperatively and with some degree of self-reliance in a group.

4.2 **The student will observe an object or event and make several inferences regarding the identity of the object or plausible reasons for the event.**
Descriptive Statement: An example would be to observe a dead tree and infer possible causes of death.

4.3 **The student will construct questions and answer them by collecting and interpreting data.**
Descriptive Statement: Sample questions are "What is the average height of students in the classroom?" and "Which of these objects conducts electricity?"

4.4 **The student will conduct simple experiments in which only one variable is manipulated and all others are held constant.**
Descriptive Statement: An example of a simple experiment would be to use the same battery, wire, and circuit pattern when testing several different materials to see if they conduct electricity.

4.5 **The student will use collected data to make inferences or predictions.**
Descriptive Statement: Examples include activities involving pendulums, or temperature changes in water as it goes from one state to another.

4.6 **The student will select the appropriate tool, take a measurement, and report it using the appropriate unit.**
Descriptive Statement: This involves using the proper tool and unit of measurement--such as using a meter stick to measure the width of the room and reporting it in meters rather than millimeters.

4.7 **The student will identify, describe, and use electrical conductors, insulators, simple circuits, dry cells (energy sources), and bulbs (energy receivers).**
Descriptive Statement: Students should have the opportunity to manipulate batteries, wires, and bulbs and conduct experiments with insulators and conductors.

4.8 **The student will describe the relationship between temperature and the three different states of matter.**
Descriptive Statement: Any given substance is coldest in the solid state and warmest as a gas.

4.9 **The student will observe basic cloud formations, and will record daily temperature and precipitation over a short period of time.**

4.10 **The student will describe the basic components of the solar system as well as major theories that have been proposed throughout history.**
Descriptive Statement: This should include relative sizes and positions of the sun, planets, and moons, but students should not be required to learn diameters, distances or other specific facts. The concept of gravity as a force in the solar system should be included.

4.11 **The student will describe some major events and contributors to space exploration and know some indirect benefits of the space program.**
Descriptive Statement: Spin-offs in fields such as medicine, computer science, and solar energy should be included.

4.12 **The student will describe ways in which the earth's surface is constantly changing.**
Descriptive Statement: Examples include soil erosion by wind and water and the effects associated with Plate Tectonics, such as earthquakes and volcanoes.

4.13 **The student will know the basic parts of plants and their function.**
Descriptive Statement: This should include the following:
Roots - draw in nutrients and water
Stems - transportation of nutrients and water
Leaves - produce food (photosynthesis)
Flowers/seeds - reproduction

4.14 **The student will describe ways in which populations of plants and animals in a community interact with one another and with their environment.**
Descriptive Statement: Examples of ecosystems to be studied are grassland, forest, desert, pond, or estuary.

4.15 **The student will understand the difference between renewable and non-renewable natural resources and will describe ways in which people sometimes misuse and waste the earth's resources.**
Descriptive Statement: Examples of renewable resources might include the sun, plants, water, and soil. Non-renewable resources include minerals and fossil fuels (coal, oil, and natural gas).

4.16 **The student will know that plants and animals produce offspring that are alike in major ways but vary enough to be individuals.**
Descriptive Statement: Careful examination of plants or animals of the same species should be conducted to observe individual similarities and differences.

4.17 **The student will infer that solids, liquids, and gases are made up of tiny bits of matter called molecules and atoms.**
Descriptive Statement: Inferences can be made by examining materials such as chalk dust, pencil marks, and sugar granules through a magnifying glass and by observing odors which can be smelled but not seen.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
FIFTH GRADE

5.1 **The student will identify and select tasks and responsibilities, and use materials in a safe manner.**
Descriptive Statement: Emphasis should be given to working cooperatively and with some degree of self-reliance.

5.2 **The student will identify problems or questions and construct valid hypotheses which can be tested.**
Descriptive Statement: An example is: Question: "What will happen to the size of an image when I look at it through two convex lenses at once?" Hypothesis: "The image will appear larger than it would through just one lens."

5.3 **The student will identify the controlled variable and the variables which are held constant in a simple experiment.**
Descriptive Statement: An example would be to have students make paper airplanes using the same paper and design (constants), then adding different numbers of paperclips (controlled variable) to study the effect of weight on flight distance.

5.4 **The student will interpret models.**
Descriptive Statement: Models are to be limited to physical representations of concrete objects.

5.5 **The student will participate in determining and evaluating his/her individual role in science activities.**
Descriptive Statement: Self-rating checklists, teacher-pupil conferences, and short written evaluations are means by which the student should assess his/her performance.

5.6 **The student will demonstrate the ability of sound to travel through solids, liquids, and gases and describe the wave nature of sound.**
Descriptive Statement: The vibration of strings, rulers and other objects should be observed to illustrate the wave nature of sound. The ability of sound to travel through solids can be observed by listening through a door or wall, and through liquid by striking rocks, metal, or other objects under water.

5.7 **The student will demonstrate and describe how pushes and pulls (both equal and unequal), and friction, affect the movement of objects.**

5.8 **The student will describe and demonstrate some properties of magnetism.**
Descriptive Statement: Properties to be included are the two poles of a magnet, the attraction and repulsion of magnets to each other and to other objects, and the illustration of magnetic fields and lines of force.

5.9 **The student will describe the effects of lenses and mirrors on the path of light.**
Descriptive Statement: Experiences should include the manipulation of lenses and mirrors and examples of their uses in instruments such as eyeglasses, cameras, telescopes and flashlights.

5.10 **The student will identify and be able to read basic instruments of weather prediction used by meteorologists.**
Descriptive Statement: Instruments to be studied should include the weather map, thermometer, barometer, anemometer, and rain gauge. Students should know the purpose of an hygrometer, but should not be required to determine humidity themselves.

5.11 **The student will identify the basic characteristics of the ocean and describe ways man has used and misused it.**
Descriptive Statement: Geological characteristics (e.g., continental shelf, slope, and rise), physical characteristics, (depth, salinity, and major currents), and biological characteristics, (ecosystems) are to be included. Fishing, overfishing, and oil spills are examples of use and misuse.

5.12 **The student will identify samples of the three classes of rocks (igenous, sedimentary, metamorphic) and tell how each is formed.**

5.13 **The student will define some of the major characteristics used to classify living things.**
Descriptive Statement: Some major classifications are:

Plants	**Animals**
Vascular (leaves, stems, roots)	Vertebrate (backbone)
flowering	mammals
cone-bearing	birds
ferns	fish
	reptiles
	amphibians
Non-Vascular	Invertebrate
moss	insects
algae	spiders
fungi (mushrooms)	worms
	shellfish

5.14 **The student will understand that all living organisms are made up of cells.**
Descriptive Statement: Students should be provided opportunities to observe cells from different organisms.

5.15 **The student will trace the complete life cycles of some plants and animals, including their death and decomposition.**
Descriptive Statement: The main emphasis should be on the natural recycling of materials in nature.

5.16 **The student will describe how plants and animals have both structural and behavioral adaptations which help them survive.**

Descriptive Statement: Examples of structural adaptation in animals are the beak and talons of an eagle, and the trunk of an elephant. Behavioral adaptations include such actions as fawns remaining motionless when danger is around, and a mother bear protecting her cubs. Some plants which have structural adaptations to their environments are cacti, water lilies, and Venus fly trap.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
SIXTH GRADE

6.1 **The student will demonstrate safety procedures in the use of laboratory equipment and materials, while working individually and in groups.**
Descriptive Statement: Students, working individually and in small groups, will use proper safety procedures with equipment and materials such as:

(1) laboratory glassware
(2) heating devices
(3) thermometers
(4) acids
(5) bases
(6) oxidizers.

6.2 **The student will use process skills as a basis for solving problems, answering questions, and providing explanations.**
Descriptive Statement: The process skills to be used are:

(1) observing
(2) classifying
(3) communicating
(4) measuring
(5) inferring
(6) predicting
(7) formulating hypotheses
(8) interpreting data
(9) constructing and interpreting models
(10) experimenting.

6.3 **The student will use appropriate materials, tools, and units of measurement in conducting scientific observations.**
Descriptive Statement: Tools to be used are:

(1) metric rulers
(2) hand lenses
(3) balances
(4) graduated containers
(5) microscopes.

6.4 **The student will use various resources to explore topics of personal interest and career opportunities in areas of science.**
Descriptive Statement: Among resources to be considered are library/media centers, industry, public agencies, and professionals in science.

6.5 **The student will observe changes and classify them as chemical or physical.**
Descriptive Statement: Suggested chemical changes to be observed are rusting of iron, decomposition of food, and acid-base reactions. Physical changes to be observed are changes in state, size, and shape.

6.6 **The student will use observation and experimentation to determine chemical and physical properties of substances.**
Descriptive Statement: Suggested properties to be observed are acidity, basicity, reactivity, decomposition of compounds, state (phase), size and shape, and solubility.

6.7 **The student will determine the relationship between changes in temperature and the states of matter for given substances.**
Descriptive Statement: Substances such as water and carbon dioxide should be used in the investigation and description of the following phase changes:

(1) melting
(2) boiling/evaporation
(3) condensation
(4) freezing
(5) sublimation.

6.8 **The student will construct models of or diagrams for atoms.**
Descriptive Statement: Models and diagrams will show the relative positions of:

(1) electrons
(2) protons
(3) neutrons
(4) nucleus.

6.9 **The student will determine electrical energy consumption using common units.**
Descriptive Statement: Units such as watt, kilowatt, and kilowatt hour should be used. Activities should include reading electric meters and calculating the energy use for a given time period, and comparing electrical consumption of appliances.

6.10 **The student will observe materials and classify them as mixtures or non-mixtures (elements and compounds).**
Descriptive Statement: Emphasis should be placed on the physical nature of separating mixtures and the chemical nature of separating compounds using such examples as iron filings and sulfur, sugar and water, salt and pepper, oil and water, and candle wax.

6.11 **The student will define kinetic and potential energy and then state examples of each.**
Descriptive Statement: Examples of kinetic energy which might be used include: automobile, bicycle, baseball or a person in motion. Examples of potential energy which might be used include: a ball at the top of its flight, water at the top of a dam, a stone held high above the pavement or the chemical energy of fossil fuels.

6.12 **The student will classify the forms of energy involved in energy transformations.**
Descriptive Statement: Examples of energy transformations to be included are electrical to heat (toaster); chemical to electrical to light (flashlight), and chemical to heat (kerosene stoves).

6.13 **The student will identify the life processes of organisms.**
Descriptive Statement: The life processes to be studied are:

(1) respiration
(2) waste removal
(3) reproduction
(4) growth
(5) irritability (response)
(6) movement
(7) energy transformation (food getting or photosynthesis).

6.14 **The student will describe the dependence of organisms upon non-living things.**
Descriptive Statement: Non-living things to be considered will include water, carbon dioxide, oxygen, sunlight, substrate (rock or soil), and minerals.

6.15 **The student will describe the differences and similarities between plants and animals.**
Descriptive Statement: Observations should be made using organisms, models and media to compare the structures of plants and animals used in fulfilling life processes.

6.16 **The student will describe the interaction and interdependence of plants and animals.**
Descriptive Statement: Investigations of food chains and food webs are to be included.

6.17 **The student will compare and contrast natural cycles.**
Descriptive Statement: Cycles to be examined are:

(1) carbon dioxide
(2) water
(3) nitrogen
(4) life.

6.18 **The student will describe the movements of the earth, sun, and moon.**
Descriptive Statement: The mechanics of producing day and night and seasonal changes of the earth and phase changes of the moon are to be studied.

6.19 **The student will describe the gravitational effects of the sun and moon upon the earth's environment.**
Descriptive Statement: The effects of gravitational forces on tidal behavior will be examined.

6.20 **The student will explain positive and negative effects of man's interaction with the environment.**
Descriptive Statement: Investigation may include such conditions as acid rain, flooding, water pollution and air pollution.

6.21 **The student will describe the uses and conservation of renewable and non-renewable resources.**
Descriptive Statement: Investigation of the following resources will be conducted:

Renewable	Nonrenewable
(1) trees	(1) oil
(2) water	(2) coal
(3) solar	(3) natural gas
(4) geothermal	

6.22 **The student will explain the relationship of the sun to most forms of energy on earth.**
Descriptive Statement: The sun is the original energy source for the energy of fossil fuels, wood, wind and water power, but not nuclear or geothermal energy.

6.23 **The student will describe the basic relationship between electricity and magnetism.**
Descriptive Statement: The magnetic field which surrounds an electric current and the generation of electricity by rotating a magnet in a coil of wire are to be examined.

6.24 **The student will identify and describe cellular components.**
Descriptive Statement: Components to be examined are:

(1) nucleus
(2) cytoplasm
(3) cell membrane
(4) cell wall.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
SEVENTH GRADE

LIFE SCIENCE

7.1 **The student will continue to use the basic process skills and will be able to employ the integrated process skills as a basis for solving problems or answering questions about the environment.**
Descriptive Statement: Basic process skills are:

(1) observing - using the five senses
(2) measuring - using metric lengths, volume, and weights as appropriate
(3) classifying - on the basis of observed differences and similarities
(4) communicating - verbal, formal and informal writing, drawings, graphing.

Integrated process skills are:

(1) inferring - providing explanations
(2) predicting - from graphs and other representations
(3) hypothesizing - formulating testable explanations
(4) modeling - constructing models to explain or illustrate phenomena
(5) interpreting data - through graphs, charts, and other representations
(6) experimenting - controlling variables to test hypotheses.

7.2 **The student will demonstrate safe and appropriate use of tools and scientific equipment for making observations about the living environment.**
Descriptive Statement: Tools and equipment such as hand lenses, metric rulers, graduates, balances, microscopes, and dissecting instruments.

7.3 **The student will exhibit evidence of personal growth and improvement by being able to select, plan, implement, and evaluate increasingly complex science experiences.**

7.4 **The student will demonstrate proper handling and care of organisms and show respect for life and property.**
Descriptive Statement: Provisions should be made for maintaining healthy organisms, providing for the safety of animals, and exhibiting conduct conducive to on-task work.

7.5 **The student will work independently and as a member of small and large groups within the classroom, in the laboratory, and during field experiences.**
Descriptive Statement: Experiences will provide the opportunity to develop independence and to develop cooperative skills and attitudes as a part of social growth and development.

7.6 **The student will explore the relationship of life science to student interests, career opportunities, and historical contributions to science.**
Descriptive Statement: Suggested activities are field trips, library media, guest speakers, and personal interviews.

7.7 **The student will be able to construct and interpret cell models.**
Descriptive Statement: Models that illustrate the following will be examined:

(1) osmosis (a kind of diffusion)
(2) cell parts
(3) mitosis and meiosis.

7.8 **The student will investigate the structural and functional organization of living things using microvisual and visual equipment to examine cells, tissues, organs, and systems.**

7.9 **The student will determine the relationship between life needs and life functions.**
Descriptive Statement: Life needs include food, water, air and space. Life functions include growth, reproduction, response to stimuli, and respiration.

7.10 **The student will recognize the basis for standard classification schemes by grouping plants and animals according to their characteristics and by designing and using a dichotomous (two factor) key.**
Descriptive Statement: Physical characteristics to be examined include color, shape, texture, and size. Behavioral characteristics to be examined include locomotion and food getting. Students should be aware of the scientific system for naming living things, but should not be required to memorize scientific names.

7.11 **The student will perform experiments and interpret data illustrating the process of photosynthesis.**
Descriptive Statement: Photosynthesis will be examined with respect to:

(1) starting materials (carbon dioxide and water)
(2) reaction products (sugar, oxygen and water)
(3) role of light (energy)
(4) role of chlorophyll (energy storage, catalyst).

7.12 **The student will describe the utilization of matter and energy within an organism.**
Descriptive Statement: Processes to be examined are:

(1) use of the products of photosynthesis as building blocks for carbohydrates, proteins and fats
(2) cellular respiration (energy yielding)
(3) growth, repair, and locomotion (energy using).

7.13 **The student will illustrate the flow of energy and matter among organisms in food chains, webs, and pyramids.**
Descriptive Statement: A variety of diagrams, games, models and investigations should be used.

7.14 **The student will investigate relationships that exist among members of a population using field and laboratory activities.**
Descriptive Statement: Competitive and cooperative interactions are to be examined.

7.15 **The student will investigate relationships among organisms in a biological community using field and laboratory activities.**
Descriptive Statement: The basic roles (producer, consumer, and decomposer) of organisms and their ecological niches (predator-prey; parasite-host; symbiotic relationship) should be examined.

7.16 **The student will compare and contrast biomes by examining relationships between abiotic and biotic factors.**
Descriptive Statement: Factors to be examined are:

(1) the physical factors (light, temperature, rainfall, etc.) which determine freshwater, marine, and land environments
(2) the structural, functional, or behavioral adaptations which enable organisms to survive.

7.17 **The student will identify the daily, seasonal, and long-term changes which occur in ecosystems, communities, populations, and organisms.**
Descriptive Statement: Charts, graphs, pictures, and written/oral descriptions and such changes as growth, phototropism, hibernation, plant dormancy, life cycles, and population fluctuations should be examined.

7.18 **The student will investigate the ways in which man's impact upon the environment affects living things.**
Descriptive Statement: Activities should include topics such as extinct, endangered, and threatened species, destruction of habitat, and availability of food.

7.19 **The student will describe conservation as a necessary practice in man's attempt to protect and wisely use the living resources of the earth.**
Descriptive Statement: Suggested topics are management of renewable resources (reforestation) and protection of endangered species.

7.20 **The student will examine the effects of heredity and environment upon organisms.**
Descriptive Statement: Topics to be investigated are:

(1) inherited and non-inherited traits
(2) mutations and their causes
(3) the role of genes and chromosomes
(4) man's ability to influence genetic patterns.

7.21 **The student will describe the theory of evolution.**
Descriptive Statement: Investigations will examine the biological evidence for evolution such as natural selection, adaptation and mutation..

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
EIGHTH GRADE

PHYSICAL SCIENCE

8.1 **The student will use process skills as a basis for defining and solving problems and answering questions related to the study of the physical environment.**
Descriptive Statement: Students will be involved in activities which include the following processes:

(1) collecting data
(2) distinguishing between observational methods
(3) distinguishing among observation, interpretation, and inference
(4) identifying and using experimental controls and data
(5) formulating conclusions
(6) writing reports of scientific investigations.

8.2 **The student will demonstrate appropriate and safe use of laboratory techniques and equipment in individual and small group activities.**
Descriptive Statement: Techniques and equipment to be considered include the following:

Laboratory Techniques

(1) using heat sources
(2) handling glassware
(3) assembling apparatus

Laboratory Equipment

(1) balance
(2) burner
(3) hand lens
(4) thermometer
(5) metric ruler
(6) graduated cylinder

8.3 **The student will make accurate and approximate measures using a variety of instruments and employing direct and indirect methods.**
Descriptive Statement: Direct and indirect methods will be used for measuring the following:

(1) volume
(2) mass
(3) length
(4) temperature
(5) time.

8.4 **The student will graph and interpret data from experiments on interacting matter and energy.**
Descriptive Statement: Data will be represented appropriately on line, bar and circular graphs. Relationships between variables will be recognized and described.

8.5 **The student will identify characteristics and examples of various types of matter by their physical and chemical properties.**
Descriptive Statement: Classes of matter and properties to be investigated are:

Classes of Matter	Physical Properties	Chemical Properties
elements, compounds, mixtures	shape	acidity
acids, bases, salts	density	basicity
organic, inorganic	solubility	combustibility
solids, liquids, gases	odor	reactivity
	melting point	
	boiling point	

8.6 **The student will construct and explain various models that illustrate the structure of an atom.**
Descriptive Statement: Representations of the Bohr and cloud models should illustrate:

(1) the arrangement of electrons, protons, and neutrons
(2) the Bohr representation of elements 1-8
(3) isotopes
(4) ions.

8.7 **The student will use the periodic chart for obtaining information about elements and inferring information about elements and binary compounds.**
Descriptive Statement: Among the information and inferences are:

Information	Inferences
symbol	chemical activity
atomic number	physical properties
atomic weight	formula of compound
chemical family	name of compound
chemical group	nature of bonding
valence	practical uses
metal, non-metal	

8.8 **The student will describe physical, chemical, and nuclear changes using the law of conservation of matter and energy.**
Descriptive Statement: Among the factors to be considered are:

Physical Change	Chemical Change	Nuclear Reactions
effect of temperature on state	type of reaction	fusion and fission
effect of particle size on solubility	evidence of reaction	products of reactions (nuclear)
effect of temperature on solubility	product(s) and reactant(s)	effects on man
	balanced equations	effects on environment

8.9 **The student will investigate energy states and forms and describe how energy is transferred, transformed, and utilized.**
Descriptive Statement: The following factors are among those to be considered:

Energy States	Energy Forms	Energy Changes	Energy Utilization
kinetic	heat	kinetic to potential	domestic
potential	light	chemical to electrical	commercial
	sound	heat to light	industrial

8.10 **The student will investigate the basic characteristics of light, and the technological applications.**
Descriptive Statement: Among the characteristics and technological applications to be examined are:

Characteristics	Technological Applications
wave nature	lasers
reflection	microscope
colors	telescope
diffraction	solar collectors
interference	

8.11 **The student will investigate the characteristics and technological applications of electricity and magnetism.**
Descriptive Statement: The following characteristics and applications are among those to be considered:

Characteristics	Technological Applications
static electricity	motors
current electricity	generators
circuits	appliances
attraction and repulsion	electronics
lines of magnetic force	computers

8.12 **The student will investigate the basic characteristics and technological applications of mechanical waves.**
Descriptive Statement: The following characteristics and applications are among those to be considered:

Characteristics	Technological Applications
reflection	music
refraction	communication
interference	hearing
sound wave motion	noise pollution
water wave motion	

8.13 **The student will investigate the scientific principles and the technological applications of work.**

Descriptive Statement: The following principles and applications to be investigated are:

Principles	Applications
work	simple machines
force	complex machines
power	
horsepower	

8.14 **The student will investigate the basic principles and technological applications of force and motion.**

Descriptive Statement: Principles and applications to be examined are:

Principles of Force and Motion	Technological Applications
gravitational forces	powered vehicles
speed	rockets
mass	restraining devices
force	projectiles
Newton's Laws of Motion	
velocity	
acceleration	

8.15 **The student will apply basic physical and chemical principles to describe changes occuring in common substances and to explain the operation of household devices.**

Descriptive Statement: Among the changes in common substances and operation of household devices to be considered are:

Common Substances	Household Devices
cleaning agents	thermostats
paints	refrigerators
food	

8.16 **The student will evaluate past and future effects of science and technology on man and the environment.**

Descriptive Statement: The following areas of concern are among those to be considered:

(1) nuclear energy
(2) organic chemicals
(3) space exploration
(4) environmental pollution
(5) energy conservation.

8.17 **The student will utilize research skills to investigate scientific, environmental, or individually selected problems.**

Descriptive Statement: Research skills involving scientific processes may be used to investigate the following areas:

Research Skills	Areas
experimentation	pollution
library resources	energy demands
interviews	nuclear energy
	food
	waste disposal
	housing

8.18 **The student will explore the relationship of physical science to student interest and career opportunities.**

Descriptive Statement: Personal interests will be explored using such resources as library media centers, professional scientists (doctors, chemists, nurses, engineers, technicians, educators), businesses, institutions, and agencies.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
NINTH GRADE

EARTH SCIENCE

9.1 **The student will exercise safe practices in the correct use of basic laboratory equipment and supplies.**
Descriptive Statement: The equipment should include but is not limited to:

Geological equipment	Astronomical equipment
rock hammer	spectroscope
Geiger counter	star chart
compass	telescope
Oceanographic instruments	**Meteorological equipment**
nansen bottle	thermometer
hydrometer	psychrometer
secci disc	barometer

9.2 **The student will apply mathematics in measuring and in problem solving.**
Descriptive Statement: Calculating the volume, mass, and density of a regular and of an irregular solid, finding distances and diameters using ratio and proportion formulas, and constructing and interpreting graphs are suggested activities.

9.3 **The student will evaluate the contributions of individuals to earth science fields, investigate career opportunities, and report their findings.**
Descriptive Statement: Sources of information include library research, interviews, attending lectures and viewing art.

9.4 **The student will relate energy sources with natural earth processes.**
Descriptive Statement: Energy sources resulting from natural earth processes to be included are fossil fuels, geothermal, wind, water and nuclear.

9.5 **The student will use appropriate terminology and laboratory techniques to identify and describe major rock forming minerals.**

Minerals	Terminology and Laboratory Techniques
quartz	crystal structure
calcite	fracture
talc	cleavage
gypsum	streak
fluorite	hardness
feldspar	luster
mica	specific gravity
ores	
gems	

9.6 **The student will apply mineral identification techniques to identify rocks and classify them according to origin.**
Descriptive Statement: Rocks to be used are:

(1) igneous — extrusive and instrusive
(2) sedimentary — clastic and nonclastic
(3) metamorphic — foliated and nonfoliated.

9.7 **The student will communicate knowledge of the rock cycle through models, diagrams and demonstrations.**

9.8 **The student will describe how the formation of surface structural features relates to the internal nature of the earth and the Plate Tectonics theory.**
Descriptive Statement: Structural features are mountains, plateaus, faults, and volcanoes.

9.9 **The student will relate the processes of weathering, erosion, and deposition to soil building, and the movement of water, both on the surface and underground.**
Descriptive Statement: Processes and effects to be included are:

Processes
weathering - chemical and mechanical
erosion - water, wind, glacial
deposition - deltas, moraines, dunes

Effects
soil building - profiles, types
karst topography - sinkholes, caves
water storage - rivers, streams, lakes

9.10 **The student will demonstrate skills in reading and interpreting maps.**
Descriptive Statement: Laboratory activities will be used with general and specialized maps such as topographic, relief, and geologic.

9.11 **The student will interpret major concepts used to describe the geologic history of the earth.**
Descriptive Statement: In describing the uses of rocks and fossils, emphasize the following:

Relative Dating
superposition
crosscutting relationships
originial horizontality
uniformitarianism
floral and faunal evolution

Absolute Dating
carbon 14
potassium-Argon
uranium 238

ASTRONOMY

9.12 **The student will describe the development of the concept of the universe and various theories of origin.**
Descriptive Statement: Concepts include geocentric and heliocentric. Theories include Big Bang, Steady State, and Oscillating Universe.

9.13 **The student will identify and describe star systems.**
Descriptive Statement: Topics should include galaxies, seasonal and circumpolar constellations, and life cycles. Study of life cycles should include changes in luminosity and surface temperature that are controlled by changes in thermo-nuclear reactions resulting from gravitational collapse.

9.14 **The student will describe the size and composition, motion, and measurements of solar system components.**
Descriptive Statement: To be included are:

Size and Composition
planets (magnetic properties)
comets (orbits and periods)
moons (size relationships to planets)
Motion
revolution
rotation
eclipses
Kepler's laws
Measurement
longitude
latitude
seasons
declination

9.15 **The student will indicate major events in man's space exploration and explain the important role the events have played in advancing technology.**
Descriptive Statement: Innovations in areas such as radio astronomy, solar energy, medicine, communications and materials development are to be included.

METEOROLOGY

9.16 **The student will interpret the hydrologic cycle through laboratory experiences, research, and observation.**
Descriptive Statement: Processes to be included are evaporation, condensation, transpiration, and precipitation.

9.17 **The student will define natural factors which determine daily weather and climates.**

Weather factors
barometric pressure
wind speed and direction
temperature
humidity
wind circulation
air mass movement

Climate factors
land masses
bodies of water
geographical location

9.18 **The student will interpret a weather map and collected data to forecast short range weather changes for the locality.**
Descriptive Statement: Factors influencing weather include: fronts, storms, cloud types, pressure, and temperature changes.

9.19 **The student will explain the structure and composition of the atmosphere and the effects of human activities on it.**

OCEANOGRAPHY

9.20 **The student will describe bathymetric features common to all ocean basins and use the plate tectonics theory to interpret their origin.**
Descriptive Statement: Charts, graphs, models, and drawings will include features such as trenches, ridges, and abyssal plains.

9.21 **The student will describe the physical and chemical properties of sea water and how they affect living systems.**

Properties
thermal
density
light filtration
composition - minerals, salts, deposits, and sediments
Living Systems
food webs
estuaries
reefs

9.22 **The student will describe the causes and effects of waves, tides, and ocean currents.**

Waves
cause - wind
effect - shoreline features
Tides
cause - interaction of earth, sun, and moon
effects - shoreline features and shipping
Ocean Currents
causes - upwelling, deposition, and density differences
effects - turbidity, salinity, and temperature.

9.23 **The student will describe past and future roles that oceans and ocean resources have had and will have in our nation's maritime heritage.**
Descriptive Statement: Roles to be considered are:

economics - fishing, shipping, drilling, and tourism
humanities - music, art, and literature
defense
exploration.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
TENTH GRADE

BIOLOGY

10.1 **The student will demonstrate appropriate safety techniques in the handling of chemicals, equipment, and organisms.**
Descriptive Statement: Proper safety techniques will be used when dissecting and observing specimens, heating materials, preparing solutions, transferring organisms, and handling glassware.

10.2 **The student will apply the scientific method to experiments.**
Descriptive Statement: Reports, laboratory practicals, investigations and observations will be used to demonstrate the ability to design experiments, interpret data, and draw conclusions.

10.3 **The student will use appropriate library research skills.**
Descriptive Statement: Abstracts, reprints, and journals will be used to prepare written or oral reports.

10.4 **The student will explore areas of interest and career opportunities in biology.**
Descriptive Statement: Field trips, career centers, and guest lecturers will provide information for class discussion and creative writing that will be used to demonstrate an awareness of biology-related careers and individually chosen topics.

10.5 **The student will understand the characteristic processes which define life.**
Descriptive Statement: The following life processes will be topics for experimentation and discussion:

(1) reproduction
(2) movement
(3) assimilation
(4) growth
(5) response
(6) energy transformation.

10.6 **The student will demonstrate an awareness of the importance of historical contributions in the development of the biological sciences.**
Descriptive Statement: Projects, objective tests, and library research are to be used when studying the contributions of Leeuwenhoek, Darwin, Pasteur, Watson, Crick, and Salk.

10.7 **The student will examine the basic chemical processes which enable organisms to meet their metabolic and developmental needs.**
Descriptive Statement: Topics for investigation will focus on projects and discussion which focus on prediction and measurement. Topics to be examined include cellular respiration, photosynthesis, carbon cycle, nitrogen cycle, and water cycle.

10.8 **The student will investigate and describe the structures and functions of cells.**
Descriptive Statement: Laboratory investigations and drawings, charts, and class discussion are to be used to describe organelles such as cytoplasm, nucleus, mitochondria, and chloroplasts.

10.9 **The student will interpret the organization of cells, tissues, organs, and systems in specified organisms to determine the order of complexity and development of life.**
Descriptive Statement: Experimentation, charts, dissections, drawings, discussion, and microscopic investigations are to be used to recognize the differences in complexity among major phyla from the protists kingdom and major classes from plantae and animalia kingdoms.

10.10 **The student will describe and interpret current and historical scientific theories on the origin of life and organic variation.**
Descriptive Statement: Observation, library research, discussion, and debates will be used to describe and interpret current and historical ideas such as Oparin hypothesis, natural selection, theory of evolution, Darwin's origin of species, LaMarck's use of disuse.

10.11 **The student will use and be able to explain the basis of the classification of organisms.**
Descriptive Statement: The examination of structural similarities and developmental patterns in establishing common ancestry will be presented through the use of charts, microscopic and macroscopic observations, dissections, and discussions.

10.12 **The student will recognize the relationships among reproductive methods adaptation, and the continuation and variation of a species.**
Descriptive Statement: Variety in asexual and sexual reproductive methods and the effects each has on the continuation and variation of a species (i.e., alternation of generation, mutation, and cloning) are to be explored.

10.13 **The student will investigate the mechanisms of inheritance.**
Descriptive Statement: Experimentation, observation, and library research will be used in compiling pedigrees and solving genetic problems (i.e., DNA, mitosis, homologous chromosomes, dominant and recessive traits, sex-linkage, genotype and phenotype).

10.14 **The student will explain the concept of homeostasis in cells, individuals, populations, communities, and ecosystems.**
Descriptive Statement: Topics such as food webs, succession, symbiosis, diffusion, and osmosis will be used.

10.15 **The student will distinguish between learned and innate behaviors.**
Descriptive Statement: Behaviors such as conditioning, imprinting, trial and error, tropism, and taxis are to be investigated through experimentation and library research.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
ELEVENTH GRADE

CHEMISTRY

11.1 **The student will demonstrate appropriate laboratory techniques and safe use of equipment while working individually and in small groups.**
Descriptive Statement: Appropriate techniques and safe use will be demonstrated when:

(1) handling burners
(2) transferring chemicals
(3) assembling apparatus
(4) causing chemicals to react
(5) wearing safety apparel
(6) handling glassware
(7) using safety equipment (fire blanket, fire extinguishers).

11.2 **The student will conduct and critically evaluate experiments in which variables are measured, analyzed, and controlled.**
Descriptive Statement: Activities and investigations should be included which provide the opportunity for:

(1) pre-lab assesment
(2) identification of variables
(3) experimental design
(4) assembling apparatus
(5) collecting data
(6) analyzing data
(7) forming conclusions
(8) making generalizations
(9) evaluating limitations.

11.3 **The student will use mathematical skills in solving problems in chemistry.**
Descriptive Statement: Emphasis should be placed on using mathematical procedures such as:

(1) metric system usage
(2) scientific notation
(3) arithmetic operations
(4) graphing (x,y coordinates)
(5) ratio and proportion
(6) percentage composition
(7) percentage error
(8) linear equations
(9) significant figures
(10) factor-label method

11.4 **The student will model the atom in terms of the location and arrangement of protons, neutrons, and electrons.**
Descriptive Statement: Models will illustrate the following features of atoms.

(1) mass number
(2) atomic number
(3) charge
(4) size
(5) mass
(6) isotopes
(7) nucleus
(8) historical models
(9) Atomic structure (sub levels, electron configuration using the s, p, d, f model for elements 1-36).

11.5 **The student will use the periodic table to interpret and predict the dependence of chemical and physical properties on electron configuration.**
Descriptive Statement: The investigations should include but not be limited to:

(1) historical development
(2) families/groups
(3) series/periods
(4) trends and patterns (atomic size, boiling and melting point, reactivity, ionization energy)
(5) relationship of electron configuration to valance/combining powers.

11.6 **The student will write chemical formulas for compounds and write balanced equations.**
Descriptive Statement: Examination of the following is to be included:

Chemical Formula	Balanced Equation
symbols	reactants and products
coefficients	use of combining patterns
subscripts	conservation of atoms and charge
nomenclature, traditional, and ICE (stock system)	oxidation and reduction

11.7 **The student will use the molar relationship given in a chemical equation to solve stoichimetric problems.**
Descriptive Statement: The following concepts will be developed quantitatively for solving the types of problems listed.

Concepts/Principles	Problems
Avogadro's principle	mass - mass
mole concept	mass - volume
proportion and/or factor-label method	volume - volume

11.8 **The student will interpret chemical bonding in terms of electrostatic force using appropriate models and notation.**
Descriptive Statement: Electron dot and structural models will be used to interpret the following types of bonding.

(1) ionic
(2) covalent
(3) polar convalent
(4) hydrogen

11.9 **The student will explain the behavior of matter in each of its three states in terms of the kinetic-molecular model.**
Descriptive Statement: The following concepts will be used, as applicable to describe the states of matter:

(1) kinetic theory
(2) pressure, volume, temperature, mole relationships
(3) vapor pressure
(4) partial pressure
(5) phase change
(6) properties and characteristics of phases.

11.10 **The student will use the kinetic-molecular theory to explain aqueous solution phenomena.**
Descriptive Statement: The concepts of molarity, equilibrium, solubility, and the collision theory model will be explained experimentally and mathematically.

11.11 **The student will use the theory of ionization to account for the behavior of ionic solutions.**
Descriptive Statement: Concepts of the ionization theory to be included are:

(1) dissociation
(2) ionization
(3) conductance.

11.12 **The student will investigate energy relationships by examining energy in physical and chemical changes.**
Descriptive Statement: The following should be investigated:

(1) endothermic and exothermic changes
(2) conservation of energy
(3) molar heats of fusion and vaporization
(4) kinetic/potential energy conversion.

11.13 **The student will explain the nature and activities of acids, bases, and salts by using the concepts of chemical equilibrium.**
Descriptive Statement: The nature of these substances will be described using both the Arrhenius and Bronsted-Lowry Theories. Experimental application of these theories will include consideration of:

(1) pH function
(2) ionization
(3) neutralization
(4) strong and weak electrolytes
(5) indicators.

11.14 **The student will select and investigate a topic in an area of biochemistry, nuclear chemistry, organic chemistry, and environmental chemistry to which basic chemical principles apply.**
Descriptive Statement: Investigations may include field study, library research, laboratory research, and projects.

11.15 **The student will explore the application of chemical principles in various occupations and interests.**
Descriptive Statement: Explorations and interests include:

(1) field trips
(2) laboratory
(3) photography
(4) interviews
(5) readings
(6) library
(7) speakers
(8) hobbies
(9) crafts.

STANDARDS OF LEARNING OBJECTIVES
SCIENCE
TWELFTH GRADE

PHYSICS

12.1 **The student will demonstrate safe and appropriate use of laboratory techniques and equipment individually and in small groups.**
Descriptive Statement: Currently accepted standards for the safe use of laboratory equipment will be followed with particular attention given to the control of hazards associated with electricity, radiation and projectiles.

12.2 **The student will solve problems in physics through the use of mathematics.**
Descriptive Statement: Algebraic equations with one unknown, scientific notation, significant digits, and physical unit analysis will be used to solve problems.

12.3 **The student will collect, analyze, and interpret physical data.**
Descriptive Statement: The following areas will be included:

(1) construct data tables
(2) construct rectangular coordinate graphs in two dimensions from data tables
(3) interpret the physical relationships between quantities from given graphs and data tables.

12.4 **The student will demonstrate the appropriate utilization of instruments to measure physical quantities.**
Descriptive Statement: Such instruments as meter sticks, ammeters, voltmeters, timers, thermometers, spring scales, balances, and graduated cylinders will be used. Absolute and relative error will be calculated.

12.5 **The student will demonstrate the appropriate use of the International Metric System with emphasis on the MKS (meter, kilogram, second) System.**
Descriptive Statement: The use of metric units in all measures and calculations is considered appropriate in this course.

12.6 **The student will solve problems involving vectors utilizing trigonometric and/or graphical methods.**
Descriptive Statement: The difference between vector and scalar quantities will be identified. Finding the resultant of at least two vectors and resolving a vector into perpendicular components will be included.

12.7 **The student will evaluate the impact of the application of discoveries of physicists and explore physics-related careers.**
Descriptive Statement: Topics which may be discussed include the application of nuclear reactions, development of artificial limbs, miniaturization of mechanical devices and the applications of electronics.

12.8 **The student will predict and verify the interrelationships among mass, distance, force and time, using both experimental and mathematical processes.**
Descriptive Statement: Quantitative descriptions of the following will be examined:

(1) linear motion
(2) curvilinear motion
(3) Newton's Law of Motion
(4) work and power.

12.9 **The student will describe mathematically the conservation of mass, energy, and momentum, and relate them to physical phenomena.**
Descriptive Statement: Topic examination will include applying mathematically the conservation laws and forming hypotheses regarding situations which involve kinetic and potential energy, elastic and inelastic collisions in one and two dimensions, and explosions.

12.10 **The student will investigate and describe the properties of solids, liquids, and gases in terms of the kinetic molecular theory.**
Descriptive Statement: Investigation should involve:

(1) listing the assumptions of the kinetic molecular theory
(2) solving mathematical problems involving pressure, volume and temperature relationships
(3) describing phase changes in terms of the kinetic molecular theory.

12.11 **The student will investigate and describe the application of energy transfer, transformation, and utilization.**
Descriptive Statement: The following aspects of energy relationships will be investigated:

(1) energy transfer (conduction, convection and radiation)
(2) heat of fusion
(3) heat of vaporization
(4) energy transforming devices (e.g. bulbs, motors, radios, refrigerators) and nature of the transformations.

12.12 **The student will interpret and use empirically developed relationships of matter.**
Descriptive Statement: Mathematical interrelationships in such laws as $F = ma$, Boyle's Law, and Ohm's Law will be verbally stated and mathematically used.

12.13 **The student will identify models of transverse and longitudinal waves and apply these to the interpretation of wave phenomena.**
Descriptive Statement: Wave characteristics such as period, wavelength, frequency, amplitude and phase are to be defined. These characteristics will be used to interpret such wave phenomena as reflection, refraction, diffraction, interference, Doppler effect, standing wave, and polarization. Light and sound will be identified in terms of wave models.

12.14 **The student will identify the main segments of the electromagnetic spectrum in terms of frequency and/or wave length.**
Descriptive Statement: The main segments of the electromagnetic spectrum such as visible light, radio, micro, infrared, gamma, and ultraviolet will be classified. The major applications of each segment should be recognized.

12.15 **The student will observe and describe the fundamental processes of reflection, refraction, and image formation in optical systems.**
Descriptive Statement: The type, size, and position of the images (real or vitual) formed by lenses and mirrors will be identified using ray diagrams and/or the mirror and lens equations. The laws of reflection and refraction are to be investigated.

12.16 **The student will describe the origins and interactions of gravitational, electrical, and magnetic fields.**
Descriptive Statement: The force relationship between the magnitude of the source and the distance from the source will be described with particular emphasis upon the mathematical application of the universal law of gravitation and Coulombs law. The empirical relationship between electric currents and magnetic fields will be described and inferences made concerning the operation of motors and generators.

12.17 **The student will diagram and construct simple electrical circuits and explain the function of circuit components.**
Descriptive Statement: Ohm's Law will be applied to series, parallel, and combined series -parallel circuits using resistors.

12.18 **The student will express the equivalence of mass and energy and identify instances where that equivalence is demonstrated.**
Descriptive Statement: Principles involved in the relationship $E = mc^2$ will be used to identify instances where mass and energy equivalence is demonstrated, such as in nuclear reactions.

APPENDIX

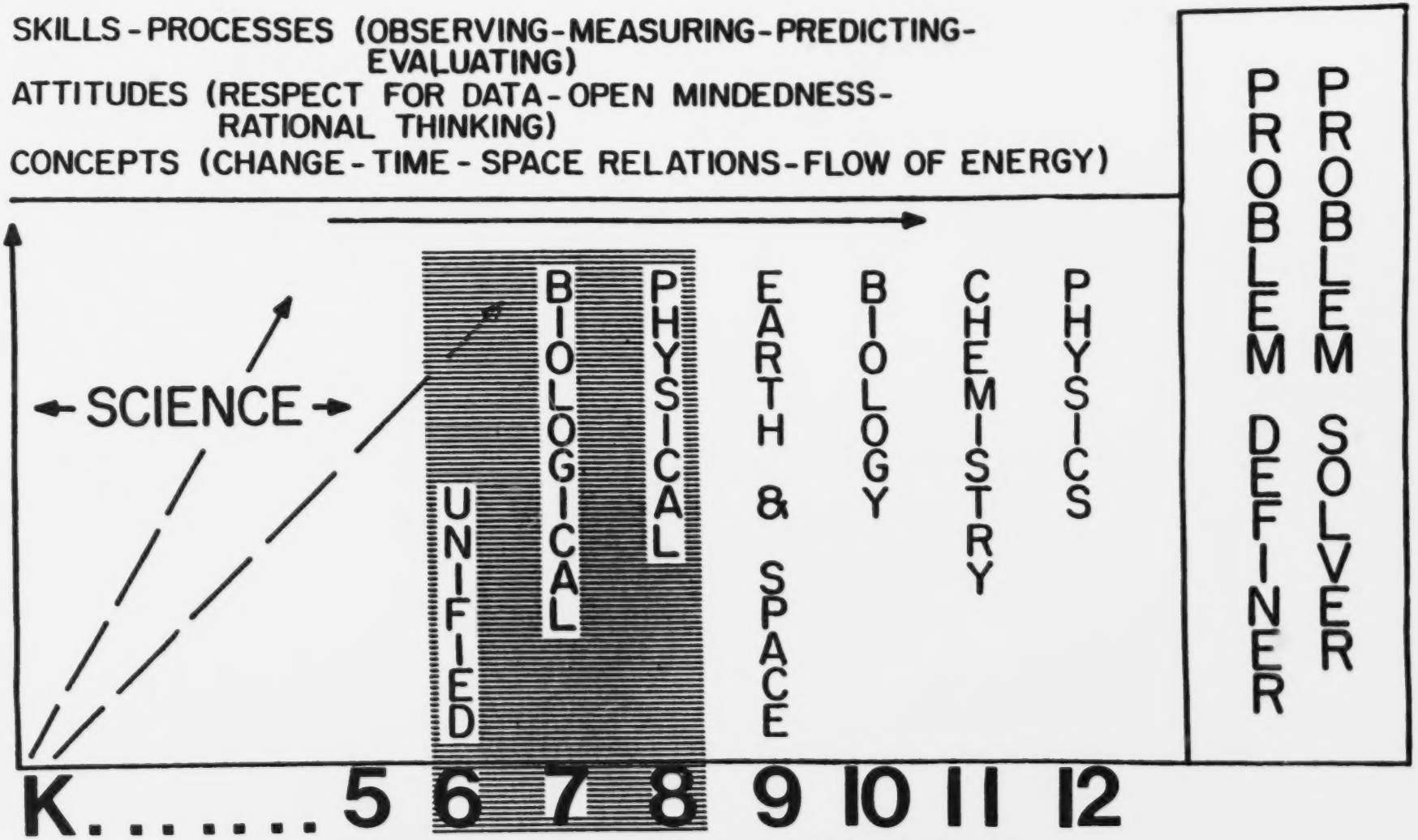

FIGURE 1: INTER RELATEDNESS OF SKILL, PROCESS, ATTITUDE AND CONCEPT DEVELOPMENT